



# Gamma Spectrum Generator for Nuclear Security

First Steps and Challenges



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# Content

- ✓ modeling for nuclear security
  - equipment testing
  - spectrum analysis support
- ✓ why nucleonica GSG?
- ✓ first results in modeling
- ✓ upcoming work
- ✓ requirements and wishlist

# Modeling for Nuclear Security

- Nuclear Security
- Detector Testing
- Analysis Support
- Nucleonica GSG
- First Modeling
- Upcoming Work
- Wishlist



- ✓ evaluation of spectrometric equipment
  - mostly NaI
- ✓ support of gamma spectrum analysis for reach back schemes (eg. MEST or triage)
  - often HPGe
- ✓ evaluation of new gamma detectors
  - eg. LaBr-3

# Evaluation of Equipment

problem: difficult to access/ short half life test source

- ✓ nuclear material (mass, matrix, shape)
- ✓ short living medical isotopes
- ✓ large volume NORM sources (eg. truck load of fertilizer)
- ✓ industrial sources (eg. in shielding container)
- ✓ orphan sources in scrap -> example from Uzbekistan

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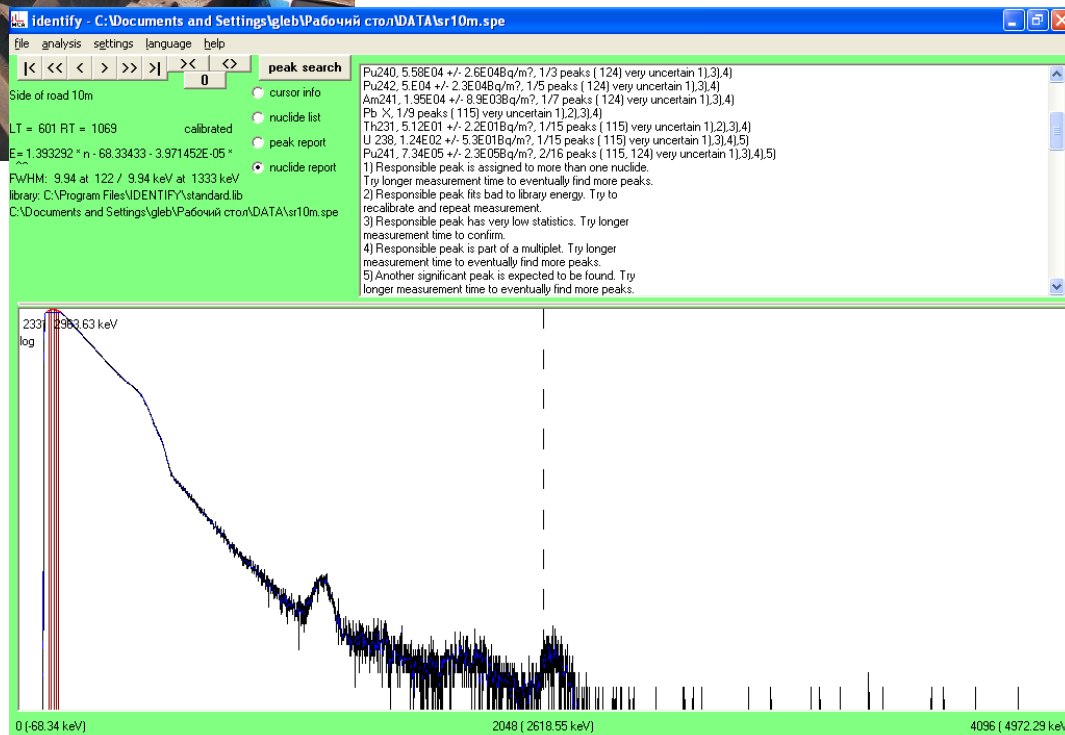


# Orphan Source in Scrap



main source Cs-137 suspected

spurious indications of other isotopes



no peaks, except K-40  
at 1460 and Th-232  
daughter at 2614 keV

*pictures from V.D.Petrenko  
(Uzbekistan)*

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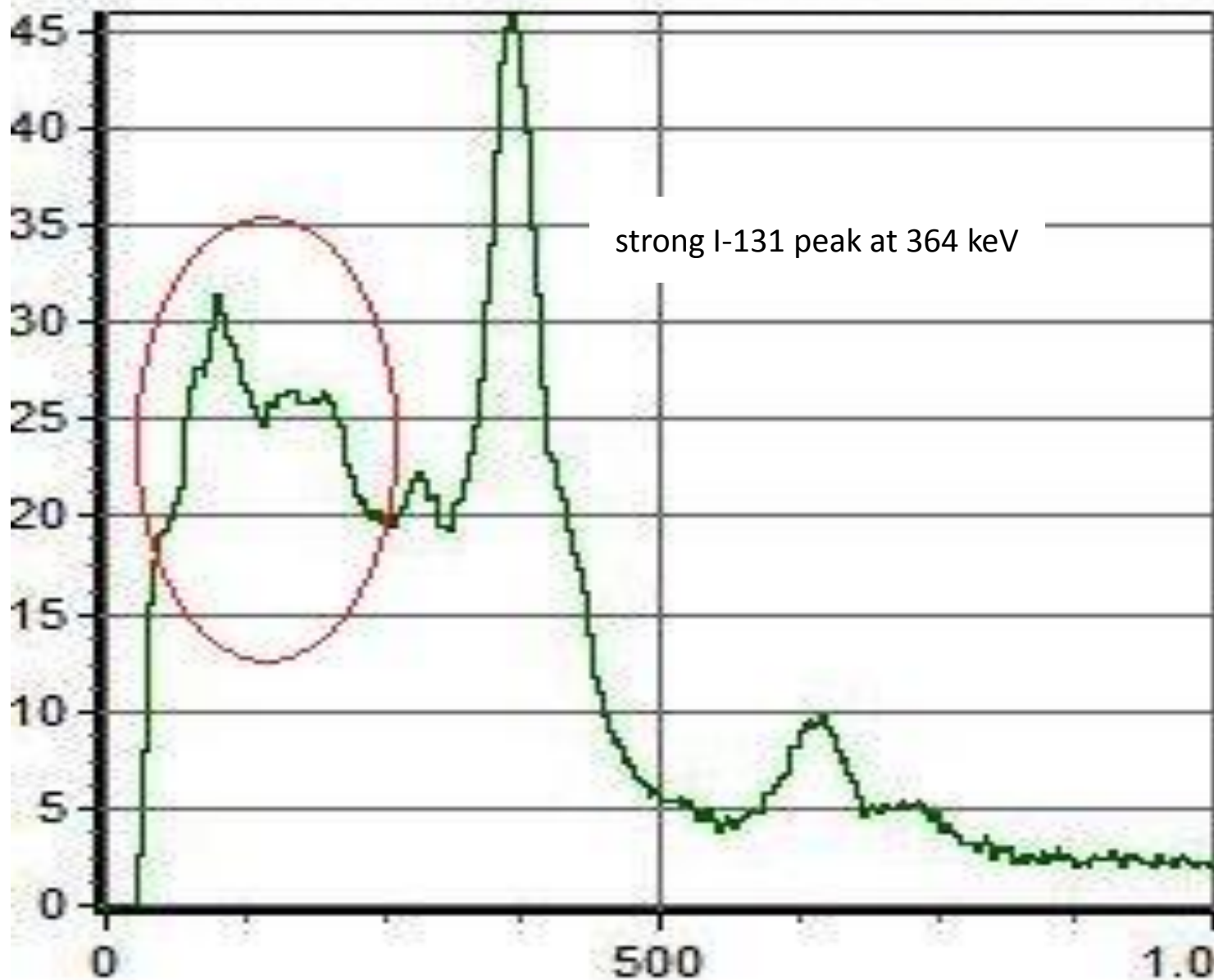
- Upcoming Work

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# I-131 masking Plutonium

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- ✓ masked isotopes (eg. NORM or medical + threat)

suggested solution: modeling with GSG as alternative to spectrum measurements

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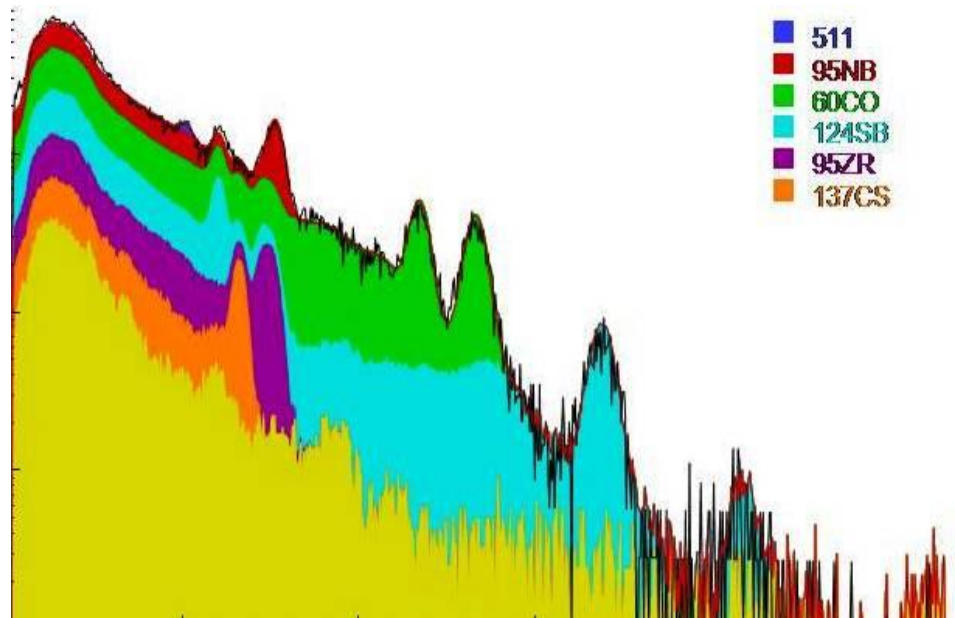




# Analysis Support for Reachback

modeling needed for

- ✓ identifying isotopes not on the list of RIDs
- ✓ activity assessment (*unknown source in unknown geometry in the field*)
- ✓ interpretation of unclear cases -> *full spectrum analysis*



spectrum consistent  
with solution in full  
shape, not only peaks

picture from G. Lasche (SNL)

# Why Nucleonica GSG?

✓ easy to use

✓ free

✓ fast



✓ expected further development

✓ problematic backscatter peak region adjustable

✓ support for our specific needs

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- **Nucleonica GSG**

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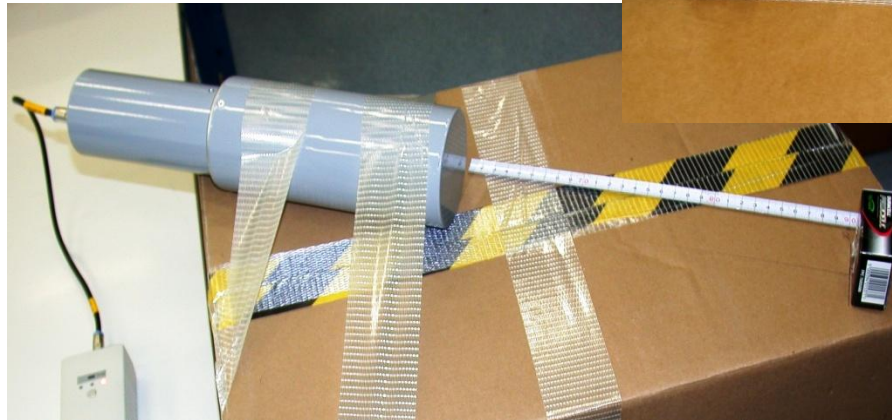
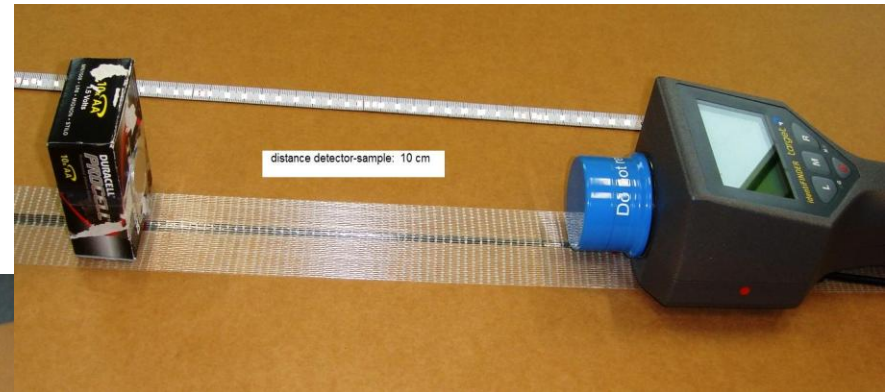
# First Steps of Modeling

check modeling with calibration sources (NaI detectors)  
compare modeled and measured spectra

- ✓ shape
- ✓ backscattering peak
- ✓ activity matching

used detectors:

Identifinder Ultra (36 x 51 mm)



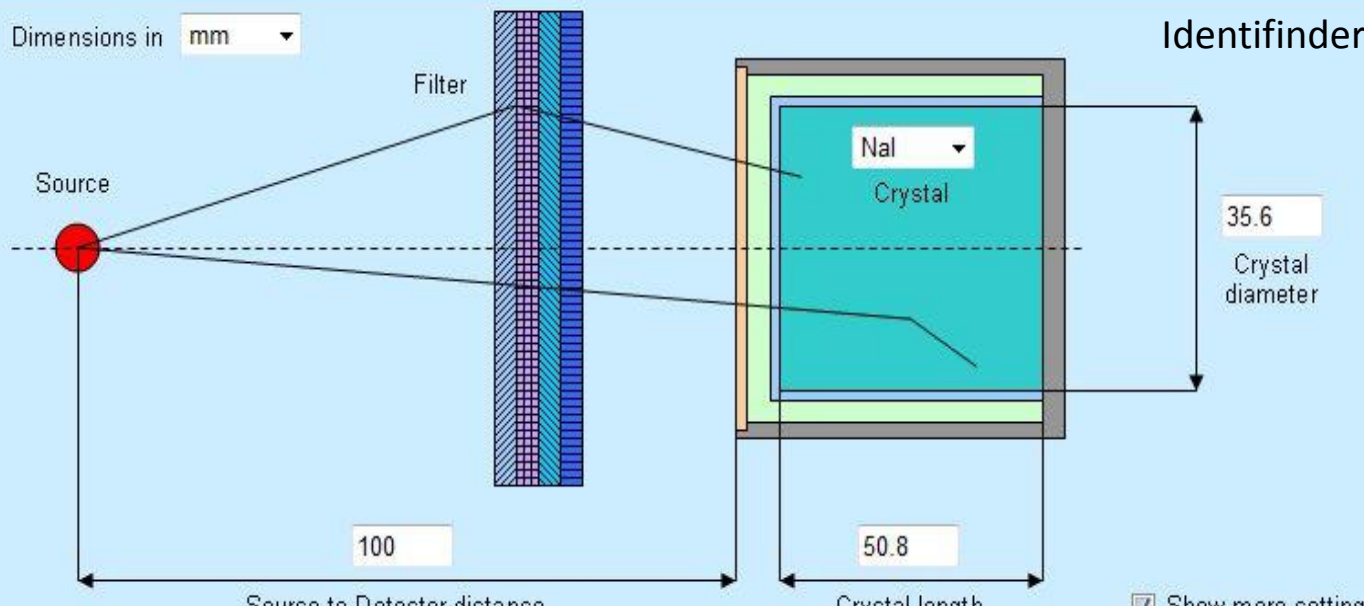
Atomtex Backpack (63 x 63 mm)

# Nucleonica Configuration

- Nuclear Security
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Dimensions in mm



Source

Filter

NaI  
Crystal

Identifinder

35.6  
Crystal diameter

100  
Source to Detector distance

50.8  
Crystal length

☒ Show more settings

	Filter:	Aluminum	1.0
	Input window:	Aluminum	0.5
	Crystal packaging:	Foam Plastic	0.0
	Inactive layer / Reflector:	Magnesium oxide	0.5

Number of channels in the spectrum accumulated: 1024

Channel-to-energy conversion factor, keV/channel: 3

Energy resolution (FWHM) in keV at 122 keV: 14.8

Energy resolution (FWHM) in keV at 1332 keV: 67.3

*measured resolution  
from Eu152 and Co60*

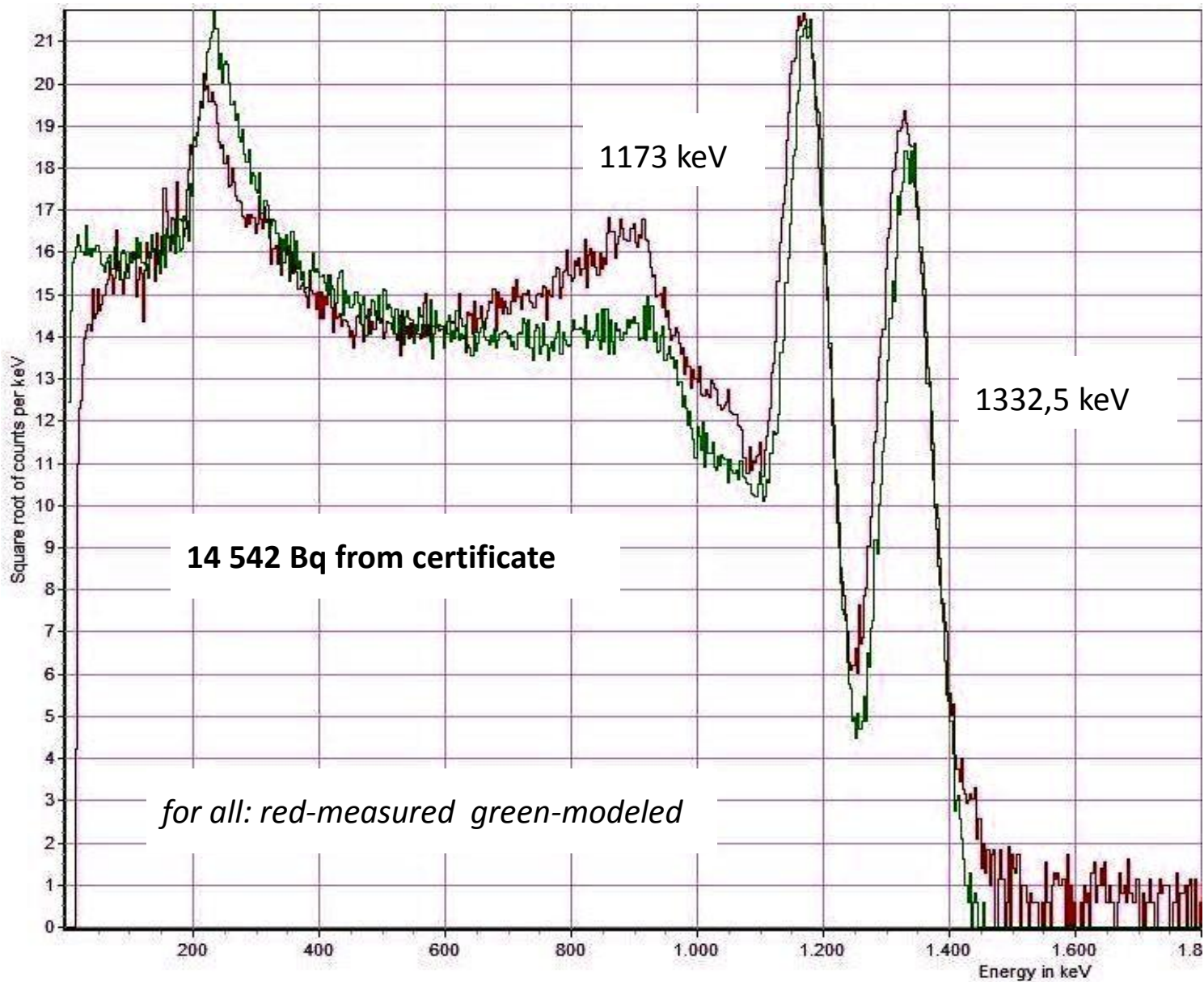
Add filter layer Remove filter layer

No.	Layer material	Thickness
0		



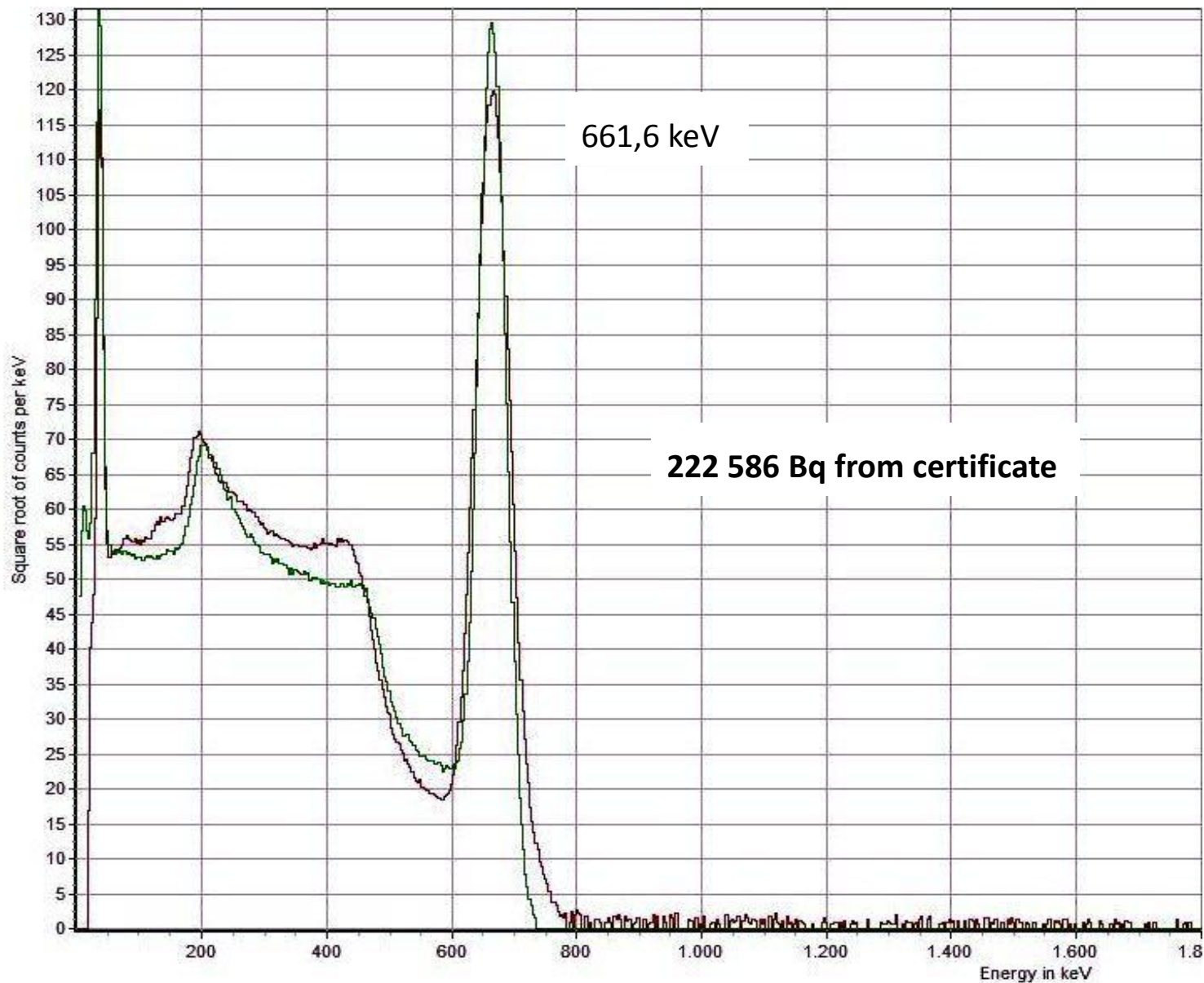
# Co-60 with Identifinder

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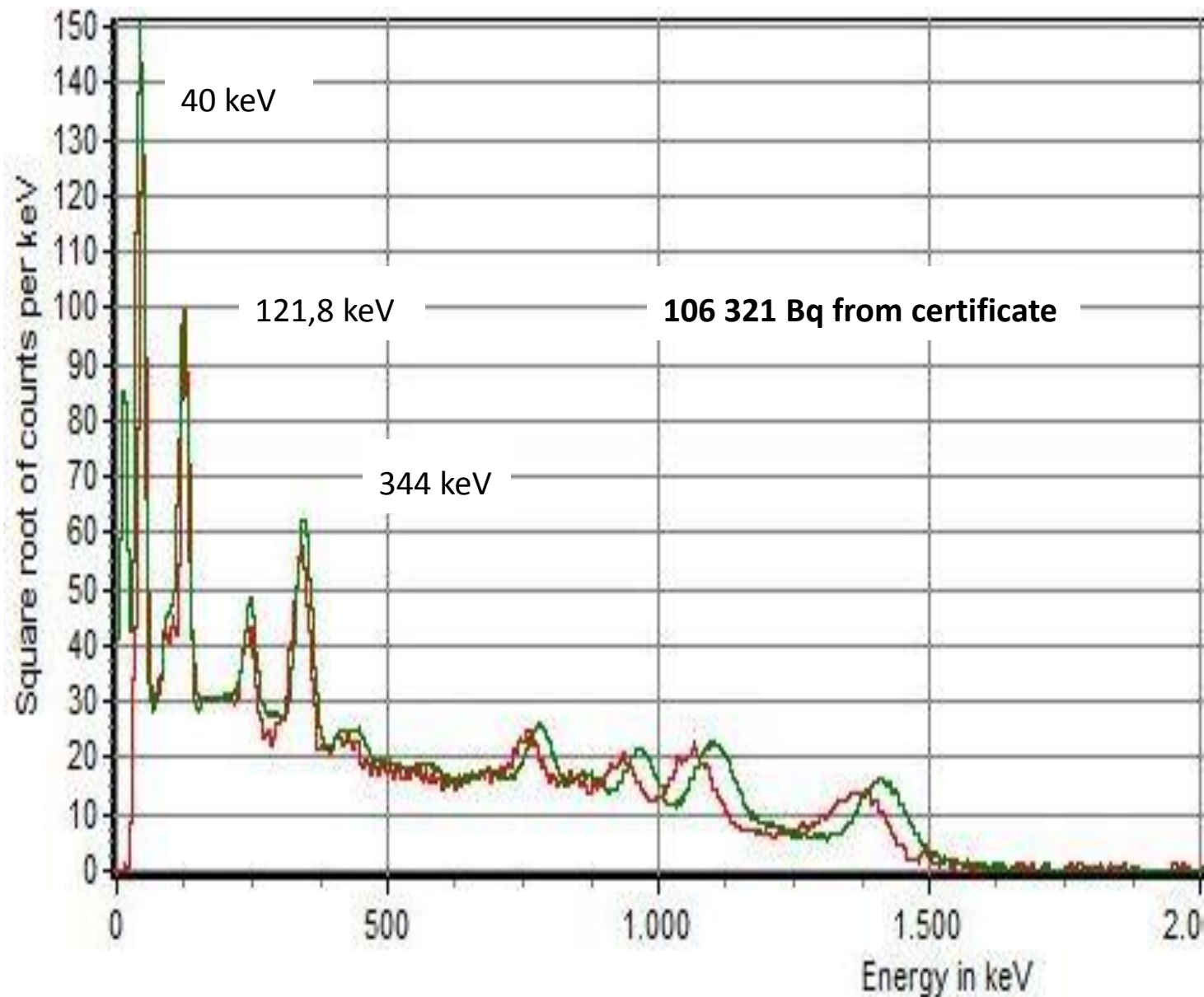


# Cs-137 with Identifinder

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# Eu-152 with 63x63 NaI



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# Upcoming Work

## spectra of not-easy-to-access isotopes

- ✓ nuclear materials of different grades
- ✓ NORM decay chains in equilibrium
- ✓ extended sources in matrices (easy montecarlo)
- ✓ absorbers, containers, shielding
- ✓ masked (mixed) isotopes
- ✓ model HPGe detector spectra -> first example

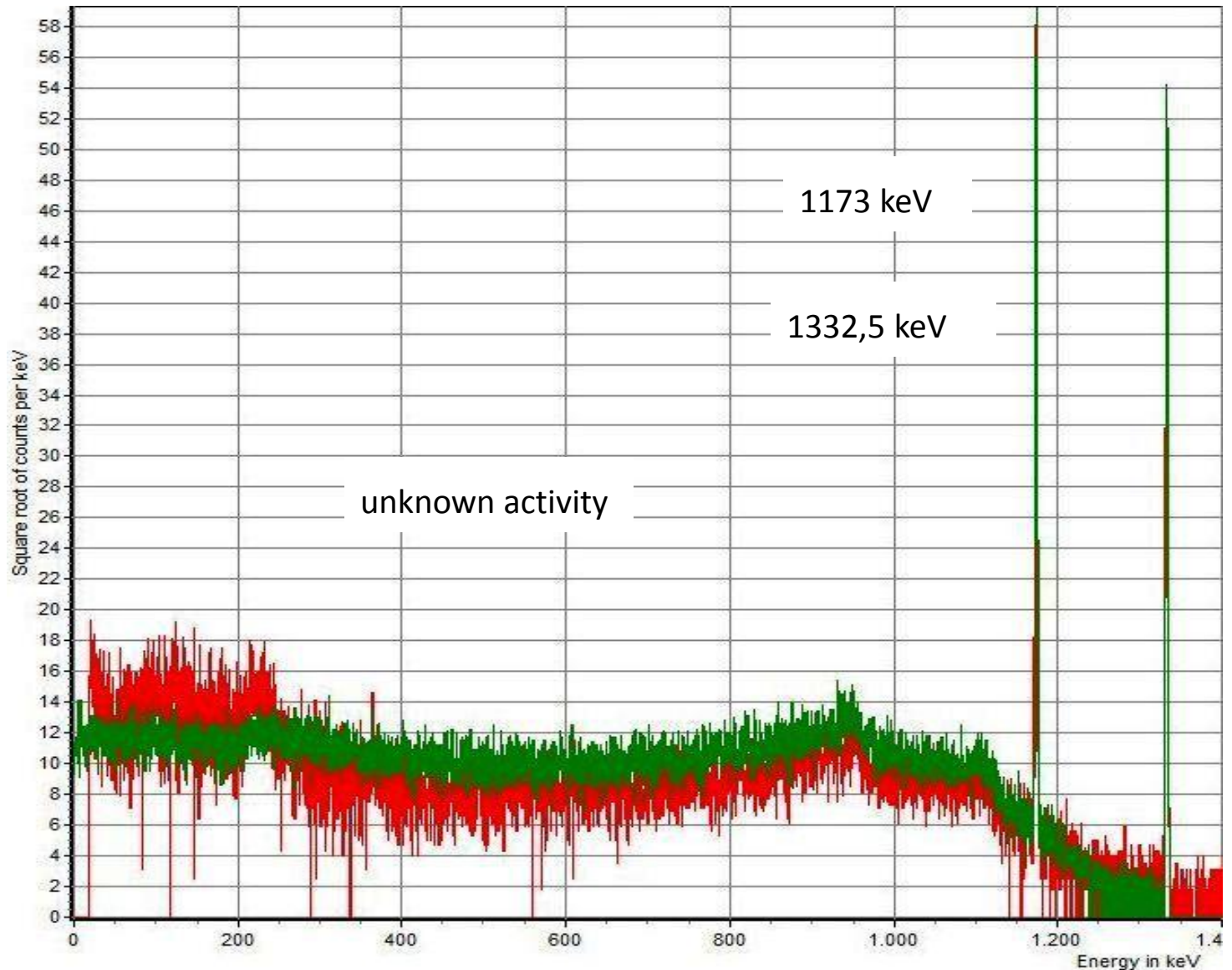
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# Co-60 with Ortec Trans-Spec

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# Upcoming Work

## spectra of not-easy-to-access isotopes

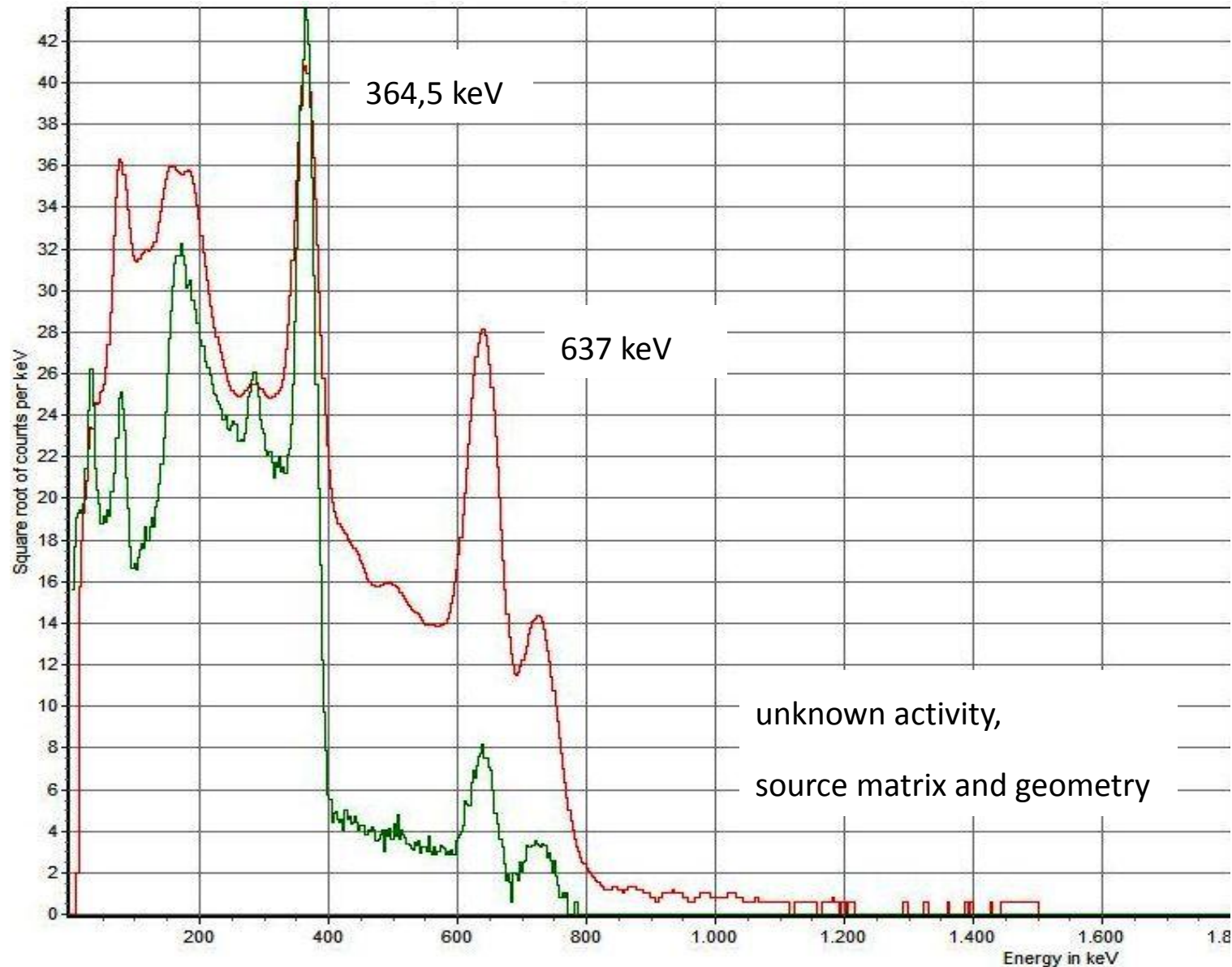
- ✓ nuclear materials of different grades
- ✓ NORM decay chains in equilibrium
- ✓ extended source matrices (easy montecarlo)
- ✓ absorbers, containers, shielding
- ✓ masked (mixed) isotopes
- ✓ model HPGe detector spectra
- ✓ medicals (in vitro and in vivo) -> first examples

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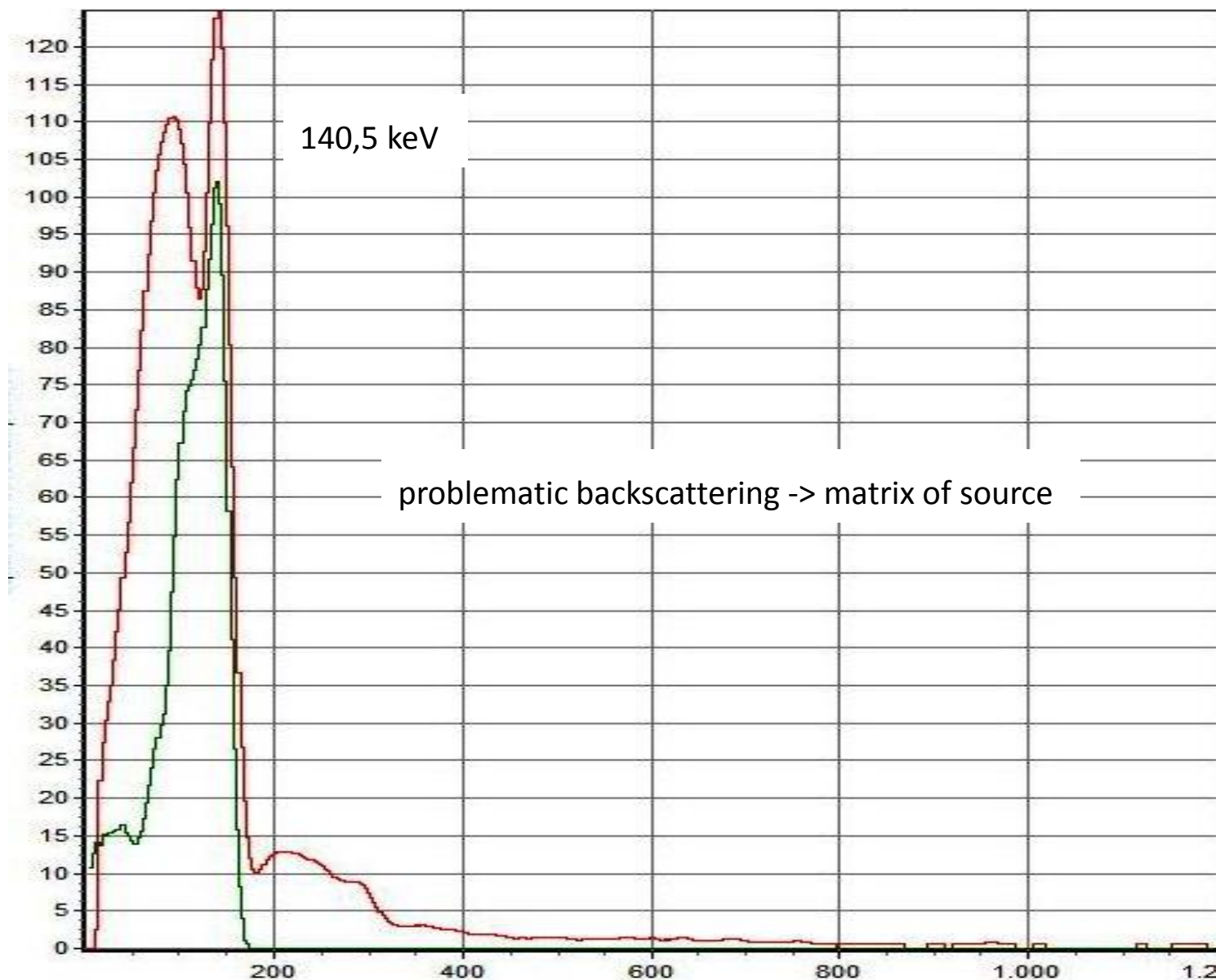
# I-131 with Identifinder

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# Tc-99m in vivo with Identifinder

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# Requirements -> Wishlist

- ✓ matrix of a sample – easy montecarlo
- ✓ pre-determined samples, mixtures and geometries
- ✓ decay chains of major naturals in equilibrium
- ✓ extended detector environment
- ✓ detector materials: LaBr-3 and LaCl-3, different HPGe types
- ✓ spectra database of sources, geometries & detectors
- ✓ file handling (plotting of two spectra to compare, integration of file converter – eg. Cambio )
- ✓ automation (parameter variation for activity matching)
- ✓ option: dose rate on detector

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# Thanks for your Attention!

## Abbreviations used:

MEST	Mobile Expert Support Team
NORM	Naturally Occurring Radioactive Material
NaI	Sodium Iodide
LaBr-3	Lanthanum Bromide
HPGe	High Purity Germanium

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